

# EXHIBIT D

# How Bad Will the Coronavirus Outbreak Get?

## Here Are 6 Key Factors

By [Knavul Sheikh](#), [Derek Watkins](#), [Jin Wu](#) and [Mika Gröndahl](#) Updated Feb. 28, 2020

As the coronavirus continues to spread around the world, a flurry of early research is drawing a clearer picture of how the pathogen behaves and the factors that will determine how much it can be contained.

### 1. How contagious is the virus?

It seems to spread very easily, making containment efforts difficult.

### 2. How deadly is the virus?

It's hard to know yet. But the fatality rate may be more than 1 percent, much higher than the seasonal flu.

### 3. How long does it take to show symptoms?

Typically between five and seven days, allowing the illness to go undetected.

### 4. How much have infected people traveled?

Enough to spread the outbreak all over the world.

### 5. How effective will the response be?

China has slowed new cases for now, but the spread around the world is accelerating.

### 6. How long will it take to develop a treatment or vaccine?

A few drugs are being tested in clinical trials, but a vaccine is still at least a year away.

While the virus is a serious public health concern, you are very unlikely to get infected outside of areas where it is spreading widely, including China, Italy, Iran and South Korea. To avoid any viral illness, experts advise washing your hands frequently and avoiding your office or school when you're sick. Most healthy people don't need masks, and hoarding them may contribute to shortages for health workers who do need them, experts say.

## 1. How contagious is the virus?

It seems to spread very easily, making containment efforts difficult.

The scale of an outbreak depends on how quickly and easily a virus is transmitted from person to person.

The new coronavirus seems to spread very easily, especially in homes, hospitals, churches, cruise ships and other confined spaces. It is much more contagious than SARS, another coronavirus that circulated in China in 2003 and sickened about 8,000 people.

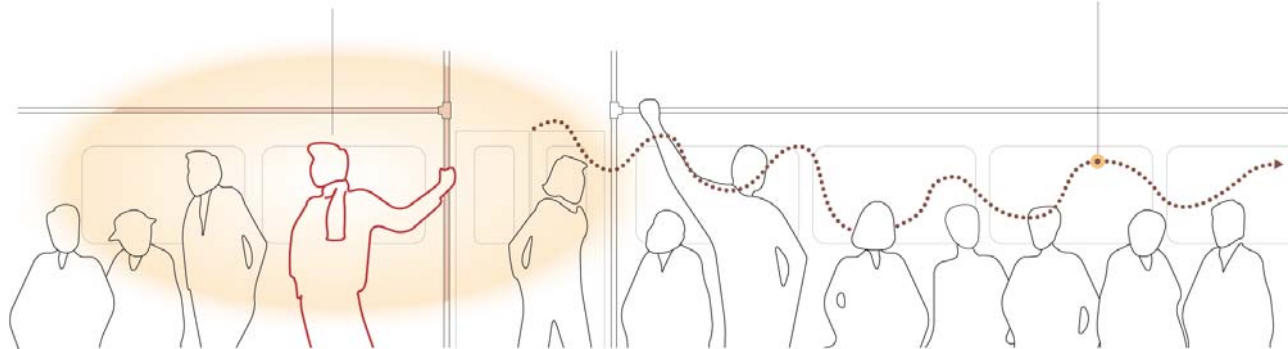
The pathogen can travel through the air, enveloped in tiny respiratory droplets that are produced when a sick person breathes, talks, coughs or sneezes.

These droplets fall to the ground within a few feet. That makes the virus harder to get than pathogens like measles, chickenpox and tuberculosis, which can travel 100 feet through the air. But it is easier to catch than H.I.V. or hepatitis, which spread only through direct contact with the bodily fluids of an infected person.

## How far viruses travel

**Coronaviruses** can travel only about six feet from the infected person. It's unknown how long they live on surfaces.

Some other viruses, like **measles**, can travel up to 100 feet and stay alive on surfaces for hours.



Research is still in its early stages, but some estimates suggest that each person with the new coronavirus could infect between two and four people without effective containment measures. That is enough to sustain and accelerate an outbreak, if nothing is done to reduce it.

Here's how that works. In the animation below, a group of five infected people could spread the virus to about 368 people over just five cycles of infection.

If 5 people with new coronavirus each infected 2.6 others ...  
... there could be **5 sick** after **1 generation**.

Compare that with a less contagious virus, like the seasonal flu, which can be slowed by vaccines and immunity from past epidemics. People with the flu tend to infect 1.3 other individuals, on average. The difference may seem small, but the result is a striking contrast: Only about 45 people might be infected in the same scenario.

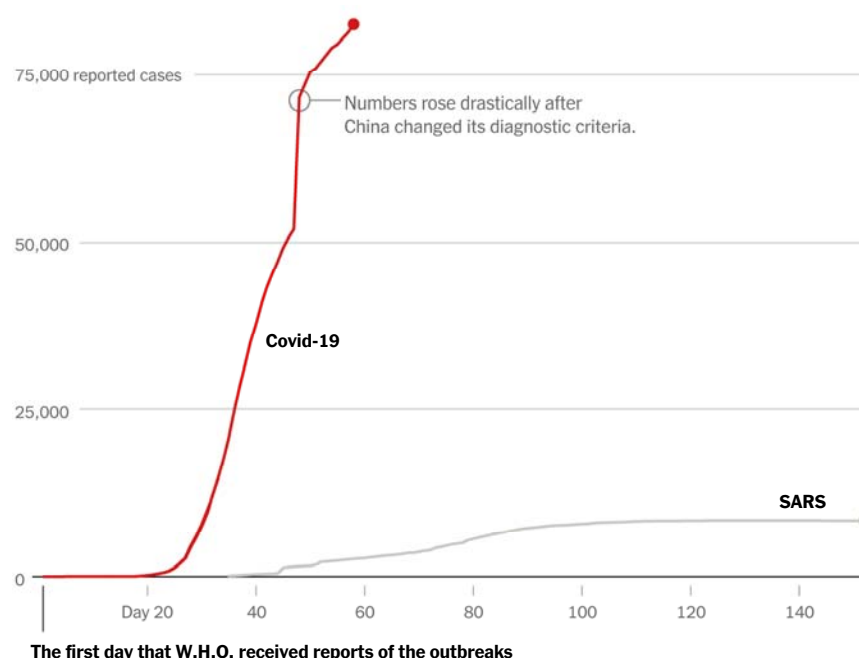
If 5 people with seasonal flu each infected 1.3 others ...  
... there could be **5 sick** after **1 generation**.

The transmission numbers of any disease aren't set in stone. They can change depending on how much people interact at school, work or religious gatherings. When global health authorities methodically tracked and isolated people infected with SARS in 2003, they were able to bring the average number each sick person infected down to 0.4, enough to stop the outbreak.

Health authorities around the world are expending enormous effort trying to repeat that. But the number of people infected globally is rising quickly, with large clusters of cases in Italy, Iran, Japan and South Korea.

The virus's high rate of transmission means containment measures — such as wearing masks, keeping a distance from infected people and implementing quarantines if people are exposed — must block more than 60 percent of transmissions in order to effectively control the outbreak, which is difficult.

Coronavirus cases have far surpassed the rate of new SARS cases in 2003:



Notes: The official World Health Organization case count for SARS was delayed at the beginning of the outbreak. Some cases were suspected but not confirmed; SARS is a diagnosis of exclusion, so previously reported cases may have been discarded after further investigation. New coronavirus data as of Feb. 27.

## 2. How deadly is the virus?

It's hard to know yet. But the fatality rate may be more than 1 percent, much higher than the seasonal flu.

This is one of the most important factors in how damaging the outbreak will be, and one of the least understood.

It's tough to assess the lethality of a new virus. The worst cases are usually detected first, which can skew our understanding of how likely patients are to die. People with mild illness may never visit a doctor, and there may be more cases than China is counting, leading to a lower death rate than initially thought.

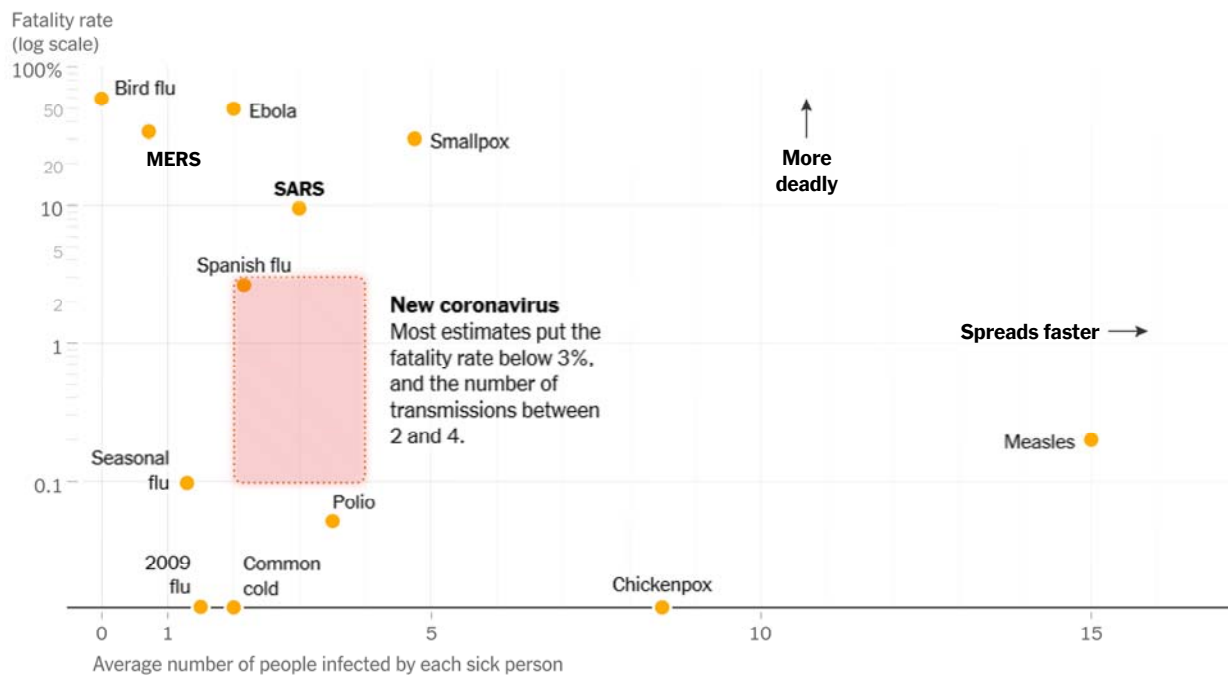
"It's easier to miss mild cases that resolve by themselves than it is to miss dead people," said Dr. Angela Rasmussen, a virologist at Columbia University's Mailman School of Public Health.

But early research indicates the virus may be significantly more deadly than the seasonal flu, which kills roughly one in 1,000 people. An analysis of outcomes for more than 44,000 confirmed patients in China found that roughly one in 50 died. Eighty-one

percent of patients infected with the new coronavirus had mild illness, 14 percent had severe illness and 5 percent had critical illness, according to the study.

The pathogen is considerably less dangerous than other coronaviruses, such as MERS, which kills about a third of people who become infected, and SARS, which kills about 1 in 10. All of the diseases appear to latch on to proteins on the surface of lung cells, but MERS and SARS seem to be more destructive to lung tissue.

Here's how the new coronavirus compares with other infectious diseases:



Note: Average case-fatality rates and transmission numbers are shown. Estimates of case-fatality rates can vary, and numbers for the new coronavirus are preliminary estimates.

The chart above uses a logarithmic vertical scale: data near the top is compressed into a smaller space to make the variation between less-deadly diseases easier to see. Diseases near the top of the chart are much deadlier than those in the middle.

Older people are much more likely to face serious illness than younger people, the analysis of Chinese patients found. In that study, nearly 15 percent of infected people over 80 died, along with 8 percent of people in their 70s. Very few young children seem to be falling ill, a pattern seen with some other respiratory viruses.

Those numbers could be reduced as more cases are discovered. And it is possible that death rates at the center of the outbreak in China, where hospitals were overwhelmed, will end up higher than elsewhere in the world.

Pathogens can still be very dangerous even if their fatality rate is low. Even though influenza has a case fatality rate below one per 1,000, roughly 200,000 people end up hospitalized with the virus each year in the United States, and about 35,000 people die.

### **3. How long does it take to show symptoms?**

Typically between five and seven days, allowing the illness to go undetected.

The time it takes for symptoms to appear after a person is infected can be vital for prevention and control. Known as the incubation period, this time can allow health officials to quarantine or observe people who may have been exposed to the virus. But if the incubation period is too long or too short, these measures may be difficult to implement.

Some illnesses, like influenza, have a short incubation period of two or three days. People may be shedding infectious virus particles before they exhibit flu symptoms, making it almost impossible to identify and isolate people who have the virus. SARS had an incubation period of about five days, and it took four or five days after symptoms started before sick people could transmit the virus. That gave officials time to stop the virus and effectively contain the outbreak.

Officials at the Centers for Disease Control and Prevention estimate that the new coronavirus has an incubation period of two to 14 days. When symptoms do start to appear, they can include fever, cough and difficulty breathing or shortness of breath.

But mild cases may simply resemble the flu or a bad cold, and people may be able to pass on the new coronavirus even before they develop obvious symptoms.

“That concerns me because it means the infection could elude detection,” said Dr. Mark Denison, an infectious disease expert at Vanderbilt University in Nashville, Tenn.

#### 4. How much have infected people traveled?

Enough to spread the outbreak all over the world.

Wuhan was a difficult place to contain an outbreak. It has 11 million people, more than New York City. On an average day, 3,500 passengers take direct flights from Wuhan to cities in other countries. These cities were among the first to report cases of the virus outside China.

##### Passengers flying from Wuhan to other countries

October to November 2019

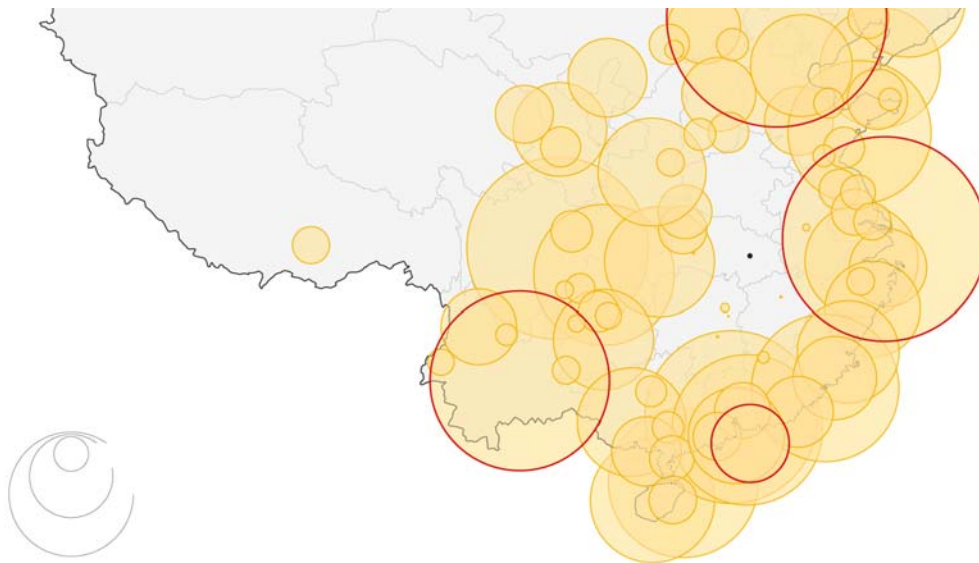


Note: Map shows passenger volume from October to November 2019, the most recent data available.

Wuhan is also a major transportation hub within China, linked to Beijing, Shanghai and other major cities by high-speed railways and domestic airlines. In October and November of last year, close to two million people flew from Wuhan to other places within China.



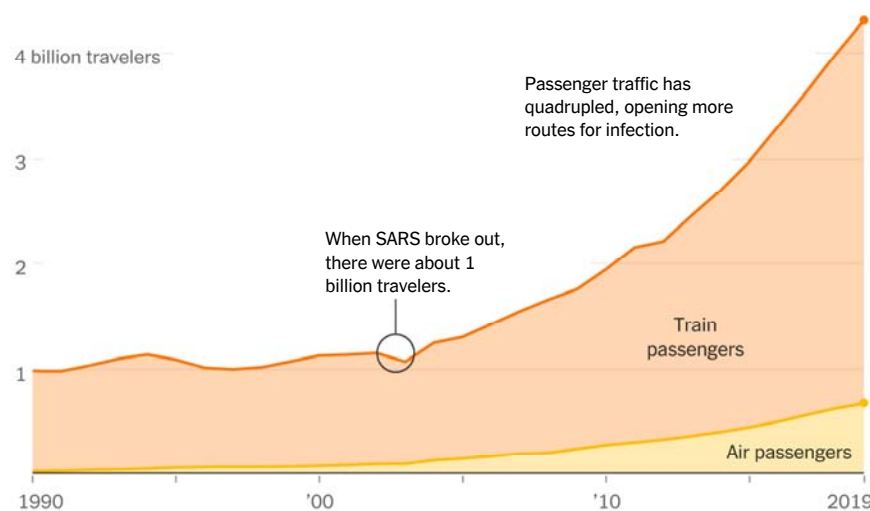




Note: Map shows passenger volume from October to November 2019, the most recent data available. Destinations with fewer than 1,000 passengers are not shown.

China was not nearly as well connected in 2003 during the SARS outbreak. Large numbers of migrant workers now travel domestically and internationally — to Africa, other parts of Asia and Latin America, where China is making an enormous infrastructure push with its Belt and Road Initiative. This travel creates a high risk for outbreaks in countries with health systems that are not equipped to handle them, like Zimbabwe, which is facing a worsening hunger and economic crisis.

Over all, China has about four times as many train and air passengers as it did during the SARS outbreak:



Note: Air travel data includes passengers only on Chinese airlines.

In January, China took the unprecedented step of imposing travel restrictions on tens of millions of people living in Wuhan and nearby cities. Some experts questioned the effectiveness of the lockdown, and Wuhan's mayor acknowledged that five million people had left the city before the restrictions began, in the run-up to the Lunar New Year.

"You can't board up a germ. A novel infection will spread," said Lawrence O. Gostin, a law professor at Georgetown University and director of the World Health Organization Collaborating Center on National and Global Health Law. "It will get out; it always does."

Several countries, including Italy, Iran and South Korea, are already discovering clusters of cases with no clear ties to the outbreak's epicenter in China. On Feb. 26, the C.D.C. also reported what it called possibly the first case of community spread in the United States.

## 5. **How effective will the response be?**

China has slowed new cases for now, but the spread around the world is accelerating.

World Health Organization officials have praised China's aggressive response to the virus — walling off cities, forcing people to stay home and tracking large numbers of contacts of infected people — saying that it helped curb the spread of more cases. The daily tally of new cases there peaked and then plateaued between Jan. 23 and Feb. 2, and has steadily declined since.

Many countries have also enacted travel restrictions and bans, closing their doors to people from countries with sustained transmission of the virus. Governments around the world have been screening incoming passengers for signs of illness. Airlines and cruise lines have canceled service to many Asian destinations.

Critics fear those measures won't be enough.

The rate at which transmissions are spreading in several countries makes it seem "unlikely that containment will be a strategy that will completely stop this virus," said Clarence Tam, an assistant professor of infectious diseases at the School of Public Health at the National University of Singapore.

The ability of nations to prepare for the arrival of coronavirus cases will depend on the strength of their health systems; their capacity to test, provide hospital beds, drugs and respirators for severely ill patients; and their effectiveness in communicating to the public.

## **6. How long will it take to develop a treatment or vaccine?**

A few drugs are being tested in clinical trials, but a vaccine is still at least a year away.

There are no approved treatments for any coronavirus diseases, including the new coronavirus.

Several drugs are being tested, and some initial findings are expected soon. An antiviral medication called remdesivir appears to be effective in animals, and it was used to treat the first American patient in Washington State. Researchers are now testing the drug in clinical trials in the United States, China and other countries.

Several groups are also working to develop a vaccine for the virus in order to stop the spread of the disease. But vaccines take time.

After the SARS outbreak in 2003, it took researchers about 20 months to get a vaccine ready for human trials. (The vaccine was never needed, because the disease was eventually contained.) By the time of the Zika outbreak in 2015, researchers had brought the development timeline down to six months.

Now, they hope that work from past outbreaks will help cut the timeline even further. Researchers have already studied the genome of the new coronavirus and found the proteins that are crucial for infection. Scientists from the National Institutes of Health, in Australia and at least three companies are working on vaccine candidates.

“If we don’t run into any unforeseen obstacles, we’ll be able to get a Phase 1 trial going within the next three months,” said Dr. Anthony Fauci, director of the National Institute of Allergy and Infectious Diseases.

Dr. Fauci cautioned that it could still take months, and even years, after initial trials to conduct extensive testing that can prove a vaccine is safe and effective. In the best case, a vaccine may become available to the public a year from now.

**Sources:**

Data on daily reported cases from the Health Commission of Hubei Province, National Health Commission of the People's Republic of China and World Health Organization.

Data on fatality rates and number of transmissions per sick person from the World Health Organization, U.S. Centers for Disease Control and Prevention, Johns Hopkins University, Global Health Data Exchange, Food and Agriculture Organization of the United States, Global Mapping of Infectious Disease Risk, National Institutes of Health, European Centre for Disease Prevention and Control, University of Oxford, Korea Institute of Oriental Medicine, Inserm, Imperial College, Harvard University, Hong Kong University, Lancaster University and University of Bern.

Travel volume data from International Air Transport Association DDS and, via CEIC, China Railway Corporation, National Railway Administration and Civil Aviation Administration of China.

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